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Indian Standard

SPECIFICATION FOR FIXED PRECISION RESISTORS

PART I GENERAL REQUIREMENTS AND METHODS OF TEST

UDC 621·316·82 : 621·38/·39·038 : 620·1

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Indian Standard

SPECIFICATION FOR FIXED PRECISION RESISTORS

PART I GENERAL REQUIREMENTS AND METHODS OF TEST

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Indian Standard

SPECIFICATION FOR FIXED PRECISION RESISTORS

PART I GENERAL REQUIREMENTS AND METHODS OF TEST

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 21 November 1979, after the draft finalized by the Resistors Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard (Part I) lays down test methods and general requirements for judging the performance of fixed precision resistors to be used in electronic and telecommunication equipment.

0.2.1 Dimensional and specific requirements of various types of precision resistors are covered in the subsequent parts of this standard.

0.3 While preparing this standard, assistance has been derived from the following documents:

IEC Publication 115-5 (1978): Sectional specification fixed precision resistors. Selection of methods of test and general requirements. International Electrotechnical Commission.

JSS 50403-1972 Detail specification for resistors, fixed precision. Directorate of Standardization, Department of Defence Production, Ministry of Defence, New Delhi

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part I) prescribes the requirements and methods of tests for judging the electrical, mechanical and climatic properties of fixed precision resistors for use in electronic and telecommunication equipment.

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*Rules for rounding off numerical values (*revised*).

1.1.1 Subsequent parts of this standard cover the dimensional and performance requirements of different types of precision resistors.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following terms and definitions, in addition to those given in IS : 1885 (Part XLVI)-1977*, shall apply.

2.1 Type Tests — Tests carried out to prove conformity with the requirements of this standard. These are intended to prove the general qualities and design of a given type of resistor.

2.2 Acceptance Tests — Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

2.3 Routine Tests — Tests carried out on each resistor to check the essential requirements which are likely to vary during production.

3. CLIMATIC CATEGORIES

3.1 The resistors covered by this standard shall be classified into climatic categories in accordance with Appendix A of IS : 589-1961†.

3.2 The severities for the cold, dry heat and damp heat (steady state) tests for the resistors covered by this standard should preferably be within the following ranges:

Lower category temperature : – 65°C to – 10°C
Upper category temperature : + 85°C to + 155°C
Damp heat (steady state) : 4 to 56 days

Values selected within these ranges shall be chosen from those listed in IS : 589-1961†.

The severities for the cold and dry heat tests are the lower and upper category temperature respectively. For some resistors these temperatures will occur between two of the preferred temperatures given in IS : 589-1961†. In this case the nearest preferred temperature within the actual range of the resistor shall be chosen.

3.3 The preferred climatic categories of different types of resistors shall be specified in the relevant specification.

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*Electrotechnical vocabulary: Part XLVI Resistors.

†Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

4. RATINGS

4.1 Rated Resistance — The preferred values of rated resistance shall be taken from a series specified in IS : 824-1965*.

4.2 Tolerance on Rated Resistance — The preferred tolerances on the rated resistance are as follows:

+ 0·01, ± 0·025, ± 0·05, ± 0·1, ± 0·25 percent, or ± 10 milliohms.

4.3 Rated Dissipation — The rated dissipation shall be chosen from the following preferred values. Unless otherwise specified, the rated dissipation shall be given with reference to an ambient temperature of 70°C.

0·862; 0·125; 0·25; 0·50; 1·00 and 2·00 W.

4.4 Limiting Element Voltage — The preferred values of limiting element voltage are:

75; 100; 150; 200; 250; 300; 350; 500; 600 and 750V dc or ac rms.

4.5 Following are the preferred stability classes:

0·25, 0·1 and 0·05 percent.

4.6 Insulation Resistance — Insulation resistance under standard atmospheric conditions shall be 1 000 M Ω minimum.

5. MATERIAL, CONSTRUCTION AND WORKMANSHIP

5.1 Material — Resistors shall be constructed from the most suitable materials which shall be free from flaws. All materials used in the construction of the resistors shall not be susceptible to any mutual chemical reaction over the entire range of climatic conditions in which the resistor is designed to operate.

5.1.1 Materials used in the moulding and coating of resistors shall not support combustion.

5.2 Construction

5.2.1 The body of the resistor shall be free from cracks, holes, chips or malformations. The wire leads shall be unbroken, not crushed or nicked.

5.2.2 Electrical connections shall be mechanically secure and electrically continuous both before and after soldering.

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*Preferred values for resistors and capacitors (*revised*).

5.3 Soldering — Generally, non-corrosive fluxes shall be used for soldering the leads of resistors and it shall be ensured that all excess fluxes have been satisfactorily removed.

5.4 Workmanship — All resistors shall be manufactured in a thoroughly workmanlike manner and in accordance with the current engineering practice.

6. STYLE REFERENCE

6.1 The style reference used shall be abbreviations to identify a particular type of resistor and shall be compared as given below in the example:

Example:

FRPR 1 — 0·125

FR denotes fixed resistor

PR denotes precision resistor

1 denotes a particular type of resistor

0·125 denotes rated dissipation in watts

7. MARKING

7.1 The following marking information in the order of importance given below, is required:

a) Rated resistance;
b) Tolerance on rated resistance;
c) Rated dissipation;
d) Week (or month) and year of manufacture;
e) Style reference; and
f) Manufacturer's type designation, if any.

7.1.1 When a coded marking is used; it shall be in accordance with IS : 8186-1976*.

7.2 The resistors shall be clearly marked with (a), (b) and (c) in **7.1** and with as many other items as is practicable.

7.3 The package containing the resistor(s) shall be clearly marked with all the information listed above.

---

*Marking codes for values and tolerances of resistors and capacitors.

7.4 Any additional marking shall be applied in such a manner that no confusion may arise.

7.5 The resistors may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

8. TESTS

8.1 Classification of Tests

8.1.1 *Type Tests* — Unless otherwise specified, the procedure for type approval shall be in accordance with IS : 2612-1965*. The sequence of type tests and number of samples for each test shall be in accordance with Table 1.

8.1.1.1 *Number of samples* — The manufacturer shall submit 210 specimens (or 140 specimens if the critical value is not included in the range) in each style of resistors for which approval is required in accordance with Table 1, the values of which shall be as follows:

a) 60 specimens of the highest value for which approval is required and 10 spares,
b) 60 specimens of the lowest value for which approval is required and 10 spares, and
c) 60 specimens of the nearest preferred value below the critical value and 10 spares.

8.1.2 *Routine Tests* — The following tests shall be carried out on each and every resistor:

a) Visual examination,
b) Resistance, and
c) Voltage proof (flash test).

NOTE — If during routine tests, more than 10 percent of the lot fails, the entire lot may be rejected.

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*Recommendation for type approval and sampling procedures for electronic components.

TABLE 1 SCHEDULE OF TYPE TESTS

(*Clause* 8.1.1)

GROUP	TEST	NUMBER OF SAMPLES			REFERENCE TO CLAUSE
		Highest Value	Lowest Value	Critical Value	
(1)	(2)	(3)	(4)	(5)	(6)
0	Visual examination Dimensions Mass Resistance Voltage proof Insulation resistance	70	70	70	8.4.1 8.4.2 8.4.3 8.3.1 8.3.4 8.3.3
1	Solderability Bump Robustness of termination Vibration Shock Acceleration (steady state) Rapid change of temperature Climatic sequence	12	12	12	8.4.5.1 8.4.7 8.4.4 8.4.6 8.4.8 8.4.9 8.5.3 8.5.1
2	Demp heat (long term)	12	12	12	8.5.2
3	Endurance Flammability	12	12	12	8.6.3 8.6.4
4	Overload (short term) Mould growth	6	6	6	8.3.7 8.6.1
5	Resistance to solvents Resistance to soldering heat	6	6	6	8.6.5 8.4.5.2
6	Temperature characteristics of resistance Temperature rise Reactance (where applicable) Salt mist	12	12	12	8.3.5 8.3.6 8.3.2 8.6.2
Spares		10	10	10	—

8.1.3 *Acceptance Tests* — The resistors which have passed the test given in **8.1.2** shall be subjected to these tests. Two groups of samples (Group A and Group B) shall be selected and the resistors shall be subjected to the tests in the order given in Table 2.

TABLE 2 SCHEDULE OF ACCEPTANCE TESTS

TEST (1)	CLAUSE REFERENCE (2)	AQL (PERCENT DEFECTIVE) (3)	INSPECTION LEVEL* (4)	*D/ND* (5)
GROUP 'A' TESTS				
Dimensions	8.4.2	1	II	*ND*
Insulation resistance	8.3.3			
GROUP 'B' TESTS				
Temperature Characteristic of resistance	8.3.5	4	S3	*ND*
Temperature rise	8.3.6			
Sub-Group 2				
Solderability	8.4.5.1	4	S3	*D*
Robustness of terminations	8.4.4			
Bump	8.4.7			
Climatic	8.5.1			
Sub-Group 3				
Endurance (168 h)	8.6.3	4	S3	*ND*

**See* Indian Standard Sampling plans and procedures for inspection by attributes for electronic items (*under preparation*).

D = Destructive   *ND* = Non-destructive

NOTE 1 — Separate samples shall be taken for each group/sub-group.

NOTE 2 — Resistors which have been subjected to the destructive tests shall not be returned to the lot.

8.2 General Conditions for Tests

8.2.1 *Selection of Samples* — The samples for test shall be so selected as to be representative of the range of resistance value, wattage rating, temperature classification and category of the resistor under consideration.

8.2.2 *Atmospheric Conditions for Tests* — Unless otherwise specified, the tests shall be carried out under standard atmospheric conditions for testing as specified in IS : 589-1961*.

8.2.3 *Preconditioning* — Where called for, before measurements are made, the resistors shall be stored at the measuring temperature for sufficient time to allow the entire resistors to reach these conditions. The recovery period allowed for after climatic conditioning is normally adequate for this purpose.

8.2.4 *Corrections to be Applied* — When measurements are made at a temperature other than the reference temperature, the results shall, wherever necessary, be corrected to the reference temperature. The ambient temperature during the test shall be stated in the report.

8.2.5 *Drying* — When drying is called for in this standard, the resistors shall be conditioned before measurements is made using procedure I or procedure II as prescribed in the relevant detail specification.

Procedure I : For 24 ± 4 hours in an oven at a temperature of 55 ± 2°C and at a relative humidity not exceeding 20 percent.

Procedure II : For 96 ± 4 hours in an oven at 100 ± 5°C.

8.2.5.1 The resistors shall be allowed to cool in a desiccator using a suitable desiccant such as activated alumina or silica gel and shall be kept therein from the time of removal from the oven to the beginning of the specified tests.

8.3 Electrical Tests

8.3.1 *Resistance*

8.3.1.1 The resistance value at 25°C shall correspond with the rated resistance taking into account the tolerance as specified in the relevant specification.

8.3.1.2 Measurements of resistance shall be made using a direct voltage of small magnitude applied for as short a time as practicable, in order that the temperature of the resistance element will not rise appreciably during measurement.

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*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

In the event of conflicting results, attributable to such test voltages, the voltage specified below shall be used for reference purposes:

Rated Resistance Ω	*Test Voltage* V Tolerance $^{+\ 0}_{-\ 10}$ percent
< 10	0·1
10 to 99	0·3
100 to 999	1
1 000 to 9 999	3
10 000 to 99 999	10
100 000 to 999 999	25
$\geqslant 1$ MΩ	50

NOTE 1 — When the rated resistance is less than 10Ω the measuring voltage shall be so chosen that the resistor is dissipating less than 10 percent of its rated dissipation, without exceeding 0·1 V.

NOTE 2 — For the measurement of resistance values below 20Ω, where the terminal resistance may affect the total resistance value, the distance between the resistor body and the mounting point on the termination shall be 6 ± 1 mm.

The accuracy of the measuring equipment shall be such that the error does not exceed 10 percent of the tolerance.

When the measurement forms part of a test sequence, any error in measuring a change in resistance shall not exceed 10 percent of the maximum change permitted for that test.

8.3.2 *Reactance (where applicable)*

8.3.2.1 The reactance test is applicable only to resistors where a low reactance is required and is specified in the detail specification. It is a suitable test for inductance in the range exhibited by wirewound resistors. The instrumentation shown in Fig. 1 may be used for resistors with a L/R time > 20 ns.

The resistance range which may be tested is from 100 Ω to 1 M Ω.

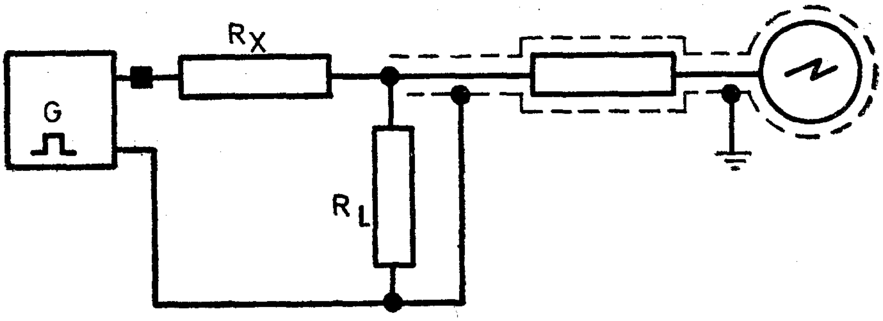
The length of the connecting leads between the generator and the resistor R_x shall not exceed 5 cm.

8.3.2.2 *Pulse generator specification*

a) Pulse width: Sufficient to cover three times L/R period;

b) Rise time on load (10 percent to 90 percent): Less than 3 ns; and

c) Repetition rate: Greater than 10 kHz or, that required to obtain good oscilloscope readability.



R_X = resistor under test.
R_L = non-inductive resistor with resistance approximately equal to 0·1 times the resistance of R_X.

FIG. 1 TEST CIRCUIT

8.3.2.3 *Oscilloscope specification*

a) Rise time (10 percent to 90 percent): Less than 12 ns (frequency response 30 MHz or better).

b) Time base: 20 ns per centimetre or faster.

c) Input capacitance at R_L should be 25 pF or less.

d) Amplification shall be sufficient to obtain good readability with the pulse voltage used.

8.3.2.4 The L/R time constant is determined by measuring the time between the start of the pulse and the time the voltage attains 63·2 percent of the maximum (*see* Fig. 2). If there is noise or distorsion at the start of the rise, the zero point may be determined by extension of the curve.

If there is no overshoot or oscillation and the L/R time is greater than 20 ns, then the formula below may be used with sufficient accuracy.

Effective inductance, $H = L/R\ (\mathrm{s}) \times R = (\Omega)$

NOTE — A specification limit could be set either as a maximum L/R time or, as a maximum value of the inductance obtained by calculation.

8.3.3 *Insulation Resistance (Applicable for Insulated Types Only)*

8.3.3.1 The test shall be performed using one of the following three methods, as prescribed in the relevant detail specification. The V-block method shall be preferred for resistors without mounting devices.

a) *V-block method* — The resistor shall be clamped in the trough of a 90° metallic V-block of such size that the resistor body does not tend beyond the extremities of the block.

b) The clamping force shall be such as to guarantee adequate contact between the resistor and the block. The clamping force is to be chosen in such a way that no destruction or damage to the resistor occurs.

The terminations shall be so positioned that the distance between the terminations and any point of the V-block is not less than:

1) For cylindrical resistors:	The radius of the resistor body minus the radius of the circumscribed circle of the terminations (the larger circle when the two terminations have different dimensions).
2) For rectangular resistors:	Half the smaller side of the resistor body minus the radius of the circumscribed circle of the terminations (the large circle when the two terminations have different dimensions).

Any out of centre positioning of the termination at its emergence from the resistor body shall be ignored.

c) *Foil method (alternative method for resistors without mounting devices)* — A metal foil shall be wrapped closely around the body of the resistor.

For resistors not having axial terminations, a space of 1 to 1·5 mm shall be left between the edge of the foil and each termination.

For resistors having axial terminations, the foil shall be wrapped around the whole body of the resistor protruding by at least 5 mm from each end, provided that the minimum space of 1 mm between the foil and the termination may be maintained. The ends of the foil shall not be folded over the ends of the resistor.

d) *Method for resistors with mounting devices* — The resistor shall be mounted in its normal manner on a metal plate (or between metal plates) which extends at last 12·5 mm beyond the mounting face of the resistor in all directions.

8.3.3.2 The insulation resistance shall be measured between both terminations of the resistor connected together as one pole and the V-block or metal foil or mounting devices, as the other pole. The measuring voltage shall be either 100 ± 15 V dc for resistors with a limiting element voltage < 500 V, or 500 ± 5V dc for resistors with a limiting element voltage $\geqslant 500$ V.

The error of measurement shall not exceed ± 10 percent.

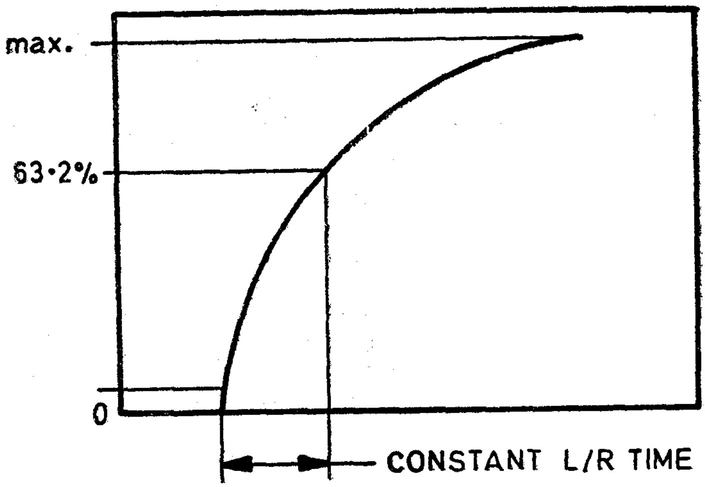


Fig. 2 Oscilloscope Trace

The voltage shall be applied for 1 minute or for such shorter time as is necessary to obtain a stable reading: the insulation resistance shall be read at the end of that period.

8.3.3.3 When measured as specified in **8.3.3.2** using one of the methods of mounting described in **8.3.3.1** the insulation resistance shall be not less than that prescribed in the relevant detail specification.

8.3.4 *Voltage Proof (Applicable for Insulated Types Only)*

8.3.4.1 The test shall be performed using one of the methods of **8.3.3.1**.

The V-block method shall be preferred for resistors without mounting devices.

8.3.4.2 An alternating voltage of 40 to 60 Hz and twice the limiting element voltage shall be applied for a period of 1 minute ± 5 seconds between the terminations of the resistor connected together as one pole and the V-block or the metal foil or the mounting plate(s) as the other pole.

The voltage shall be applied gradually at a rate of approximately 100 V/s.

8.3.4.3 When tested as specified in **8.3.3.2** using one of the methods of mounting described in **8.3.3.1**, there shall be no breakdown or flashover.

8.3.4.4 *Flash test* — When required as a flash test, the voltage as specified in **8.3.3.2** shall be applied for 2 seconds between the terminations of the resistor connected together as one pole and the V-block or the metal foil or the mounting plate(s) as the other pole.

There shall be no breakdown or flashover.

8.3.5 *Temperature Characteristic of Resistance*

8.3.5.1 The resistors shall be dried as specified in **8.2.5**.

8.3.5.2 The resistors shall be maintained at each of the following temperatures in turn or at other temperatures specified in relevant detail specification for 4 hours or until temperature equilibrium is reached:

a) 25 ± 3°C
b) Lower category temperature ± 3°C
c) 25 ± 3°C
d) 70 ± 2°C
e) Upper category temperature ± 2°C
f) 70 ± 2°C
g) 25 ± 3°C

This cycle shall be carried out once. Thermal shock shall be avoided.

8.3.5.3 The resistance shall be measured in accordance with **8.3.1** at each of the temperature mentioned above after the resistor has reached that temperature; and with the same electrical test conditions for all the measurements. The temperature of the resistor at the time of each measurement shall be recorded. The error of measurement of temperature shall not exceed 1°C.

8.3.5.4 The temperature characteristic of resistance shall be computed from the following formulae:

$$\text{Temperature characteristic of resistance} = \frac{100 \, \Delta R}{R} \times K$$

where

$$K = \frac{\text{Difference between nominal specified temperatures}}{\text{Difference between recorded temperature}}$$

If the resistance recorded above are designated R_a, R_b, R_d, R_e, R_f and R_g respectively; R and $\triangle R$ are given as below:

	27°C to lower category temperature	*70°C to upper category temperature*	*20°C to 70°C*
R	$\frac{R_a + R_c}{2}$	$\frac{R_d + R_f}{2}$	$\frac{R_c + R_f}{2}$
$\triangle R$	$R_b - R$	$R_c - R$	$\frac{R_d + R_f}{2} - R$

8.3.5.5 The temperature characteristic of resistance, determined as described above, shall not exceed that specified in relevant detail specification for the appropriate category temperature.

8.3.6 *Temperature Rise* — Resistors having a rated resistance equal to or less than the critical resistance value shall be subjected to the following test.

8.3.6.1 The resistor shall be mounted horizontally. The connections shall be made in the usual manner as for endurance test. For resistors with soldering tags, copper wire of approximately 1·0 mm diameter shall be used for connecting the resistors. The relevant detail specification shall prescribe any special mounting arrangements.

8.3.6.2 The ambient temperature for the test shall be 15°C to 35°C. There shall be no air circulation other than that produced by the convection current caused by the heated resistor.

8.3.6.3 The rated voltage shall be applied.

8.3.6.4 The temperature at the hottest point of the resistor shall be measured after temperature equilibrium has been attained. The temperature measuring device shall be of such dimensions as not to affect the measurement.

8.3.6.5 The temperature rise shall not exceed the value prescribed in the relevant detail specification.

8.3.7 *Overload (Short Term)*

8.3.7.1 The resistance shall be measured as specified in **8.3.1**.

8.3.7.2 The resistor shall be mounted horizontally. For wirewound resistors, the axis of the winding shall be horizontal. The resistor shall be in free air at an ambient temperature between 15°C and 35°C. A voltage shall then be applied to the terminations of the resistor. The value of the voltage and the duration of its application shall be as prescribed in the relevant detail specification.

Connections shall be made in the usual manner as for endurance test. For resistors with soldering tags, copper wire of approximately 1·0 mm diameter shall be used for connecting the resistors. The detail specification shall prescribe any special mounting arrangements.

8.3.7.3 After recovery for not less then 1 hour nor more than 2 hours, the resistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

8.3.7.4 The resistance shall then be measured. The change of resistance, with respect to the value measured in **8.3.6.1**, shall not exceed the value prescribed in the relevant detail specification.

8.4 Mechanical Tests

8.4.1 *Visual Examination* — The resistors shall be visually examined for compliance with the requirements of marking and finish. There shall be no corrosion, cracks, fracture and loosening of parts.

8.4.2 *Dimensions* — The dimensions of the resistors and their terminations shall be checked for compliance with those specified in the relevant detail specification.

8.4.3 *Mass* — The mass shall be as specified in the relevant detail specification.

8.4.4 *Robustness of Termination*

8.4.4.1 The resistors shall be subjected to the procedures of tests detailed in **7.19** of IS : 589-1961*, as applicable.

NOTE 1 — Bending test and torsion test shall not be applied if the relevant detail specification described the termination as rigid.

NOTE 2 — For resistors having ferrule type terminations, the load to be used and method of testing are under consideration.

8.4.4.2 The resistors shall be measured as specified in **8.3.1**.

8.4.4.3 *Tensile test* — This test shall be carried out in accordance with **7.19.1** of IS : 589-1961*. The loading weight shall be as given below:

a) For all types of terminations except wire terminations — 2·0 kg.

b) *For wire terminations*:

Cross-Sectional Area of Wire	*Corresponding Approximate Diameter*	*Load*
mm^2	mm	kg
Exceeding 0·5	Above 0·8	2
Exceeding 0·2 up to and including 0·5	0·5 to 0·8	1
Exceeding 0·07 up to and including 0·2	0·3 to 0·5	0·5
Up to and including 0·07	Up to 0·3	0·25

8.4.4.4 *Bend test*

a) *For wire terminations* — The bend test on wire terminations shall be carried out in accordance with **7.19.2.2** of IS : 589-1961*. Care shall be taken to ensure that the bend occurs at a point 6 mm away from the point of emergence of the wire from the resistor and around a radius of 0·75 mm. A suitable arrangement to ensure this requirement is shown in Fig. 3. The number of bending operations shall be 2, unless otherwise specified in ther elevant detail specifications.

NOTE — This test shall be carried out on one-half of the specimens while on the other half the torsion test (*see* **8.4.4.5**) shall be carried out.

b) *For tag terminations* — The bending test on tag type terminations shall be carried out in accordance with **7.19.2.3** of IS : 589-1961*. Each soldering tag shall be subjected to the two cycles of bending.

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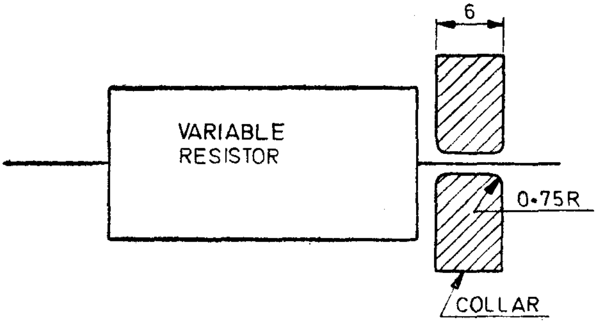

FIG. 3 ARRANGEMENT FOR BEND TEST

8.4.4.5 *Torsion test*

a) *For wire terminations* — The torsion test on wire termination shall be carried out in accordance with **7.19.3** of IS : 589-1961*. Two successive rotations of 180° shall be performed.

b) *For nuts and threaded terminations* — The torsion test on nuts and threaded terminations shall be carried out in accordance with **7.19.4** of IS : 589-1961*.

8.4.4.6 *Final measurements* — After each of these tests, the resistors shall be visually examined. There shall be no visible damage. The resistance shall then be measured. The change of resistance compared with the value measured in **8.4.4.2** shall not exceed the value specified in the relevant detail specification.

8.4.5 *Soldering*

8.4.5.1 *Solderability* — The resistors shall be subjected to one of the procedures specified in **7.18** of IS : 589-1961*. The relevant detail specification shall prescribe which method is preferred and shall give the additional information as required.

Where the detail specification states that terminations are suitable for use with printed wiring, they shall be tested at the point not more than 2 mm from where the termination emerges from the body of the resistor.

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*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

The requirements for the appropriate procedure shall be fulfilled as stated in IS : 589-1961* for the solder bath or the soldering iron methods.

In the case of the solder globule method, the detail specification shall indicate the soldering time.

8.4.5.2 *Resistance to soldering heat* — The resistors shall be dried using Procedure I or Procedure II of **8.2.5** as called for in the detail specification.

When the resistance to soldering heat test is to be applied immediately after the solderability test, the drying procedure may be performed prior to the solderability test.

The resistance shall then be measured as specified in **8.3.1**.

The resistors shall then be subjected to one of the procedures for resistance to soldering heat prescribed in **7.18** of IS : 589-1961* as specified in the relevant detail specification.

When the test procedure have been carried out, the resistors shall be visually examined. There shall be no visible damage and the marking shall be legible. The resistance shall then be measured as specified in **8.3.1.** The change of resistance with respect to the value measured initially shall not exceed the limit prescribed in the relevant detail specification.

8.4.6 *Vibration* — The resistors shall be subjected to the vibration (fatigue) test in accordance with **7.6** of IS : 589-1961*, with the severities as specified in the relevant detail specification.

8.4.6.1 Resistors shall be mounted by their normal means. Where this is by axial wire terminations the distance between the resistor body and the mounting point on the termination shall be 6 ± 1 mm.

For resistors without specific means of mounting and weighing more than 15 g, the relevant detail specification shall state whether or not the body of the resistor shall be restrained.

8.4.6.2 When specified in the relevant detail specification an electrical measurement shall be made to determine intermittent contact or open or short circuit. The duration of the measurement shall be the time needed for one sweep of the frequency range from one frequency extreme to the other.

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*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

8.4.6.3 After the test, the resistors shall be visually examined. There shall be no visible damage. The resistance shall then be measured. The change in resistance value shall not exceed the limits specified in the relevant detail specification.

8.4.7 *Bump* — The resistor shall be subjected to the bump test in accordance with **7.5.1** of IS : 589-1961*, with the severity as specified in the relevant detail specification.

8.4.7.1 The resistor shall be mounted as specified in **8.4.5.1** and in such a manner that equal numbers are bumped along the three principal axes.

8.4.7.2 When specified in the relevant detail specification, an electrical measurement shall be made to determine intermittent contact or open or short circuit. The duration of measurement shall be the time needed for one sweep of the frequency range from one frequency extreme to the other.

8.4.7.3 After the test, the resistor shall be visually examined. There shall be no visible damage. The resistance shall then be measured. The change in resistance value shall not exceed the limits specified in the relevant detail specification.

8.4.8 *Shock* — The resistors shall be subjected to the shock test in accordance with **7.5.2** of IS : 589-1961*, at the severity specified in the relevant detail specification.

8.4.8.1 Unless otherwise specified, the resistors shall be mounted as specified in **8.4.5.1**.

8.4.8.2 When specified in the relevant detail specification, an electrical measurement shall be made to determine intermittent contact or open or short circuit. The duration of measurement shall be the time needed for one sweep of the frequency range from one frequency extreme to the other.

8.4.8.3 After the test, the resistor shall be visually examined. There shall be no visible damage. The resistance shall then be measured. The change in resistance value shall not exceed the limits specified in the relevant detail specification.

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*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

8.4.9 *Acceleration (Steady State)* — The resistors shall be subjected to acceleration (steady state) test in accordance with **7.7** of IS : 589-1961* at the severity specified in the relevant detail specification.

8.4.9.1 Unless otherwise specified, the resistors shall be mounted as specified in **8.4.5.1**.

8.4.9.2 When specified in the relevant detail specification, an electrical measurement shall be made to determine intermittent contact or open or short circuit. The duration of measurement shall be the time needed for one sweep of the frequency range from one frequency extreme to the other.

8.4.9.3 After the test, the resistor shall be visually examined. There shall be no visible damage. The resistance shall then be measured. The change in resistance value shall not exceed the limits specified in the relevant detail specification.

8.5 Climatic Tests

8.5.1 *Climatic Sequence* — An interval of not more than 3 days is permitted between any of these tests, except between damp heat (accelerated) first cycle and cold. In this case, the cold test shall follow immediately after recovery period specified for the damp heat test.

The tests and measurements should be performed in the order stated hereafter.

8.5.1.1 *Initial measurements* — The resistance shall be measured, as specified in **8.3.1**.

8.5.1.2 *Dry heat* — The resistors shall be subjected to dry heat test in accordance with **7.2** of IS : 589-1961* for 16 hours.

After the specified conditioning, the resistors shall be removed from the chamber and exposed to standard atmospheric conditions for recovery for not less than 4 hours.

8.5.1.3 *Damp heat (accelerated) first cycle* — The resistors shall be subjected to the first cycle of damp heat (accelerated) test in accordance with **7.4** of IS : 589-1961*.

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*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

After recovery, the resistors shall be immediately subjected to the cold test.

8.5.1.4 *Cold* — The resistors shall be subjected to the cold test in accordance with **7.1** of IS : 589-1961* for 2 hours with the following modification:

After the specified conditioning, the resistors shall be removed from the chamber and exposed to the standard atmospheric conditions for recovery for not less than 4 hours.

8.5.1.5 *Low air pressure* — The resistors shall be subjected to the low air pressure test in accordance with **7.12** of IS : 589-1961*, using the appropriate degree of severity.

During the last 5 minutes of the test the resistors shall be loaded with 70 percent of the rated voltage (or 50 percent of the rated wattage) subject to a maximum of 70 percent of the limiting voltage. There shall be no breakdown, spark or flashover.

The test shall be carried out at a temperature between 15°C and 35°C. The duration of the test shall be 1 hour.

8.5.1.6 *Damp heat (accelerated) remaining cycles* — The resistors shall be subjected to the remaining cycles of the damp heat (accelerated) test in accordance with **7.4** of IS : 589-1961*. The number of cycles shall be five.

Within 15 minutes after removal from the chamber, the resistor shall be subjected to a dc voltage for one minute. The voltage shall be the rated voltage or the limiting element voltage whichever is smaller. The resistor shall then remain under standard atmospheric conditions for recovery before the final measurements are made. Recovery period shall be 1 to 2 hours.

8.5.1.7 *Final measurements* — After recovery the resistors shall be visually examined. There shall be no visible damage and marking shall be legible.

The resistance and the insulation resistance (for insulated types only) shall then be measured. The change of resistance compared with the value initially measured shall not exceed the value specified in relevant detail specification. The insulation resistance shall not be less than that specified in the relevant detail specification.

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*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

8.5.2 *Damp Heat (Long Term)* — The resistors shall be subjected to this test in accordance with **7.3** of IS : 589-1961*, using the appropriate degree of severity.

8.5.2.1 The resistance shall be measured as in **8.3.1**.

8.5.2.2 For resistors which are normally mounted on or between metal plates with or without additional insulation, the lot shall be divided into three equal parts:

a) One part shall be subjected to this test without voltage applied.

b) Second part shall be subjected to this test with a direct voltage applied between the terminations. The voltage to be applied shall be selected from the following series:

0, 4, 6·3, 10, 16, 25, 40, 63 and 100 V.

The voltage to be applied shall be such that the resistor is dissipating 1 percent of the rated dissipation, or shall be the limiting element voltage, whichever is the smaller.

c) Third part shall be subjected to a direct voltage of 20 ± 2 V between the mounting plates and one of the terminations. The mounting plates are connected to the negative pole, the termination to the positive pole of the voltage source. The voltage shall be applied continuously, throughout the test.

8.5.2.3 For all other resistors the lot shall be divided into two equal parts:

a) One part shall be subjected to this test without voltage applied, and

b) Second part shall be subjected to this test with a direct voltage applied between the terminations. The voltage to be applied shall be such that the resistor a dissipating 50 percent of the rated dissipation or the limiting element voltage, whichever is smaller.

NOTE — The voltage over the total test period shall be kept as closely as possible to the specified voltage, the tolerance of ±5 percent is allowed for mains voltage fluctuations and similar factors.

8.5.2.4 Within 15 minutes after removal from the chamber, the resistor shall be subjected to a dc voltage for 1 minute. The voltage shall be the rated voltage or the limiting element voltage whichever is smaller. The resistor shall then remain under standard atmospheric conditions for recovery before the final measurements are made. Recovery period shall be 1 to 2 hours for category 1 and 20 to 24 hours for category 2 resistors.

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*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

8.5.2.5 After recovery the resistors shall be visually examined. There shall be no visible damage and marking shall be legible.

For insulated types, voltage proof and insulation resistance test shall be made. There shall be no breakdown or flash over. The insulation resistance shall be not less than that specified in the relevant detail specification.

The resistance then shall be measured and the change in resistance value compared with the value initially measured shall not exceed the value, as specified in the relevant detail specification.

Following this resistors shall be subjected to the solderability test and meet requirements specified therein.

8.5.3 *Rapid Change of Temperature* — The resistors shall be subjected to 5 cyclyes of rapid change of temperature in accordance with **7.14** of IS : 589-1961*. Unless otherwise specified, the duration of the exposure at each of the extremes of temperature shall be 30 minutes. The resistors shall then remain under standard atmospheric conditions for recovery for 1 hour to 2 hours. After recovery, the resistors shall be visually examined. There shall be no damage and the markings shall be legible.

The resistance shall then be measured and it shall conform to the requirement stated in the relevant specification.

8.6 Miscellaneous Tests

8.6.1 *Mould Growth* — This test shall be carried out in accordance with **7.9** of IS : 589-1961* and shall satisfy the requirements specified therein.

8.6.2 *Salt Mist* — The resistor shall be subjected to salt mist test in accordance with **7.10** of IS : 589-1961*. The duration of the test shall be 48 hours, unless otherwise specified. After recovery, the resistors shall be visually examined and shall conform to the requirements of **8.4.1**.

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*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

The resistance and insulation resistance (for insulated type only) shall be measured. The change in resistance compared with the value measured in **8.3.1**, shall not exceed the limits specified in the relevant detail specification.

The insulation resistance shall not be less than that specified in relevant detail specification.

8.6.3 *Endurance* — When changes in the slope of the derating curve occur at temperatures other than 70°C, one of the following additional procedures shall apply:

a) *At temperature, lower than 70°C* (for example, where a resistor is derated linearly from 20°C, through 70°C, to zero dissipation at the upper category temperature, or where a resistor has constant dissipation from 20°C to 40°C and is then derated linearly from 40°C, through 70°C to zero dissipation at the upper category temperature). Resistors shall be subjected to the conditions specified in **8.6.3.1**(a) (endurance at 70°C) except that:

   1) the test temperature shall be that at which the change of the slope of the derating curve occurs; and

   2) the voltage to be applied shall be that calculated from the square root of the product of the rated resistance and the dissipation at test temperature or it shall be the limiting element voltage, whichever is the smaller.

   The test dissipation shall be calculated using the following formula:

$$W_t = W_R + (W_R - W_C) \left(\frac{70 - T_t}{T_{UC} - 70} \right)$$

where

W_t = dissipation in W at test temperature,

W_R = rated dissipation in W,

W_C = category dissipation in W,

T_t = test temperature in °C, and

T_{UC} = upper category temperature in °C.

b) *At temperature higher than 70°C* [for example, where a resistor maintains its rated dissipation constant from 20°C, through 70°C, to (say) 125°C, and then is derated linearly to either zero dissipation or the category dissipation at the upper category temperature]. Resistors shall be subjected to the conditions specified in **8.6.3.1**(a) (endurance at 70°C) except that the test temperature shall be that at which the change in the slope of the derating curve occurs.

The requirements for intermediate and final measurements in (a) and (b) above shall be the same as those specified in the relevant detail specification for the endurance test used to verify the rated dissipation.

8.6.3.1 The resistors intended for this test shall be divided into two groups. One of them shall be subjected to the endurance at 70°C while the other to the endurance at upper category temperature.

a) *Endurance at 70°C* — The resistance shall be measured as specified in **8.3.1**. The resistors shall then be subjected to an endurance test for 1 000 hours at an ambient temperature of 70 ± 2°C.

A direct voltage or full wave rectified ac voltage (provided that the ripple does not exceed 5 percent) shall be applied to the resistor in cycles of 1½ hours 'on' and ½ hours 'off' throughout the test.

The voltage shall be the rated voltage or the limiting element voltage, whichever is less. At all times during the test, the applied voltage shall be within ± 5 percent of this voltage.

NOTE — The half-hour 'off' periods are included in the total tests duration specified above.

The resistors shall be connected by their terminations to suitable clips on a rack of insulating material. All resistors shall be mounted in a horizontal position, in one layer only, unless otherwise specified in the relevant detail specification. The distance between the axes of the resistors shall be not less than seven times the diameter of the resistors. There shall be no undue draught over the resistors. Only natural convection resulting from the hot resistors may occur.

The size of the testing chamber and the number of resistors under test shall be such that when all resistors are fully loaded, the heat produced by them shall be less than that required to maintain the atmosphere in the chamber at 70°C so that the temperature may still be controlled by the heating elements.

The temperature controlling elements shall be suitably spaced from the resistors and shall be shielded so as not to be directly influenced by the radiation of the resistors.

It shall be assumed in this test that the ambient temperature of the resistors is 70°C.

After approximately 48, 168, 250, 500 and 1 000 hours, the resistors shall be removed from the chamber and allowed to recover under standard atmospheric conditions for testing for not less than one hour and not more than 2 hours. The removal from the chamber shall take place at the end of the half-hour 'off' period.

The resistor shall be visually examined. There shall be no visible damage.

The resistance shall then be measured and the change in resistance value compared with the initially measured value in each of the succeeding measurements shall not exceed that specified in the relevant detail specification.

After intermediate measurements the resistors shall be returned to the test chamber. The interval between the removal of any resistor from the chamber and its return to the conditions of test shall not exceed 12 hours.

After the completion of the test (1 000 h) the insulation resistance (for insulated types only) and resistance shall be measured. The value of the insulation resistance shall not be less than that specified in the relevant detail specification. The change in resistance value compared with the initially measured value, shall not exceed that specified in the relevant detail specification.

b) *Endurance at upper category temperature* — The resistance shall be measured as specified in **8.3.1**. The resistors shall be subjected to an endurance test for 1 000 hours, at an ambient temperature equal to the upper category temperature given in the relevant detail specification.

A voltage shall be applied to the resistors in cycles of 1½ hours 'on' and ½ hour 'off' throughout the test. The use of ac or dc shall comply with the requirements of the endurance tests at rating temperature. The voltage shall be the limiting element voltage or the voltage calculated from the category dissipation and the rated resistance whichever is less. At all times during the test the applied voltage shall be within ± 5 percent of this voltage.

NOTE — The half-hour 'off' periods are included in the total test duration specified above.

Those resistors which are dissipation power during this test shall be mounted in the test chamber at 200°C in the manner required in the endurance test at rated temperature.

All other resistors shall be placed in the test chamber at their appropriate temperatures in such a manner that the spacing between resistors is at least one diameter.

When the resistors are dissipating power, they shall be mounted in the same manner as specified in **8.3.6.1**(a).

There shall be no undue draught over the resistors. If forced air circulation is used in the test chamber, the resistors shall be protected so that there is no draught, other than by natural convection, over the resistors.

The size of the testing chamber and the number of resistors under test shall be such that when all resistors are fully loaded, the heat produced by them shall be less than that required to maintain the atmosphere in the chamber at the upper category temperature so that the temperature may still be controlled by the heating elements.

The temperature controlling elements shall be suitably spaced from the resistors and shall be shielded so as not to be directly influenced by the radiation of the resistors.

It shall be assumed in this test that the ambient temperature of the resistors is the same as the upper category temperature.

After approximately 48, 168, 250, 500 and 1 000 hours, the resistors shall be removed from the chamber and allowed to recover under standard atmospheric conditions for testing for not less than 1 hour and not more than 2 hours.

The removal from the chamber shall take place at the end of the half-hour 'off' period, for those resistors which are dissipating power.

The resistors shall then be visually examined. There shall be no visible damage.

The resistance shall then be measured.

The change of resistance with respect to the value initially measured in each of the succeeding measurements shall not exceed the value prescribed in the relevant detail specification for the corresponding endurance test at 70°C or at room temperature.

After intermediate measurements the resistors shall be returned to the test chamber. The interval between the removal of any resistor from the chamber and its return to the chamber shall not exceed 12 hours.

After completion of the test (1 000 hours) the insulation resistance (for insulated types) and resistance shall be measured and the value shall be not less than that prescribed in the relevant detail specification.

The change in resistance value compared with the initially measured value, shall not exceed that specified in the relevant detail specification.

8.6.4 *Flammability* — This test shall be carried out in accordance with the procedure as given in Appendix A.

8.6.5 *Resistance to Solvents* — This test shall be carried out in accordance with the IS : 9000 (Part XX) - 1979*.

APPENDIX A

(*Clause* 8.6.4)

FLAMMABILITY TEST

A-1. OBJECT

A-1.1 This test is intended to determine whether resistors will support combustion.

A-2. TEST CHAMBER

A-2.1 The chamber used for this test shall have the following provisions:

a) An enclosure protected from air currents, but provided with means of venting fumes and admitting an adequte supply of fresh air at the bottom.

NOTE 1 — A metal box about 600 mm wide, 900 mm high and 600 mm deep, with a detachable front, a viewing window and suitable holes for intake of air and venting of fumes may be used.

NOTE 2 — Adequate safety precautions shall be taken to protect personnel from possible explosion of the components.

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*Basic environmental testing procedures for electronic and electrical items: Part XX Resistance to cleaning solvents and permanence of markings.

b) A suitable stand or support for the resistors involving a minimum of heat transfer; and

c) A spirit burner of the pattern shown in Fig. 4. The fuel for the burner shall be good quality 66° O P industrial methylated spirit containing not more than 5 percent of wood naptha (*see* IS : 324-1959*). The burner and the flame are considered satisfactory if a bare copper wire of 0·71 mm diameter having a free length of not less than 100 mm in the flame in the position to be occupied by the resistors melts in less than 6 seconds.

NOTE — The melting point of a copper is 1083°C.

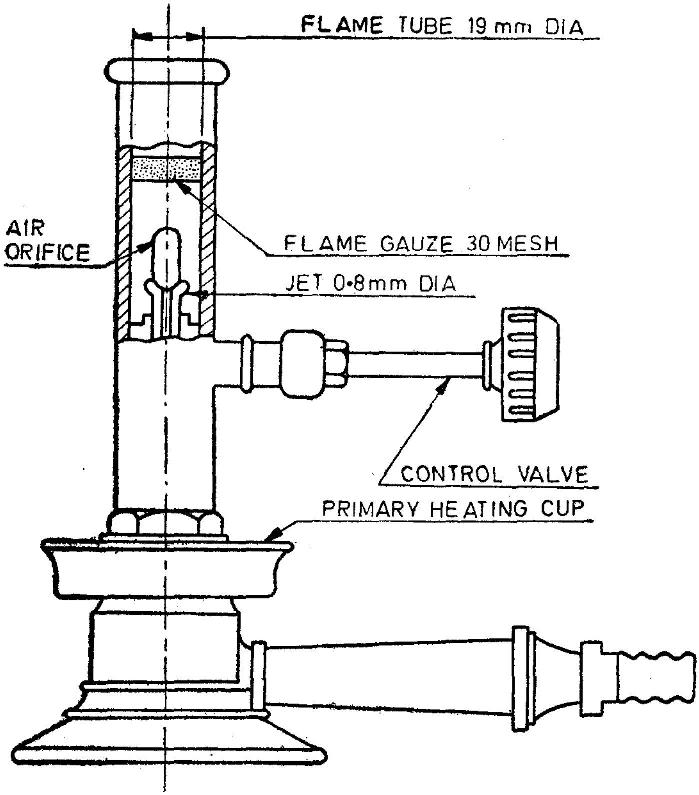

FIG. 4 SPIRIT BURNER

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*Specification for ordinary denatured spirit (*revised*).

A-3. MOUNTING

A-3.1 The resistors shall be mounted on the stand placed within the test chamber in such a manner that they are not shielded from the flame by the support. The precise orientation of the resistors relative to the flame if not stated in the relevant detail specification, shall be that judged to be the most unfavourable on which presents maximum surface to the test flame.

A-3.2 The height of the resistors shall be so adjusted that the lowest part of the resistors body is 51 mm from the top of the burner as shown in Fig. 5.

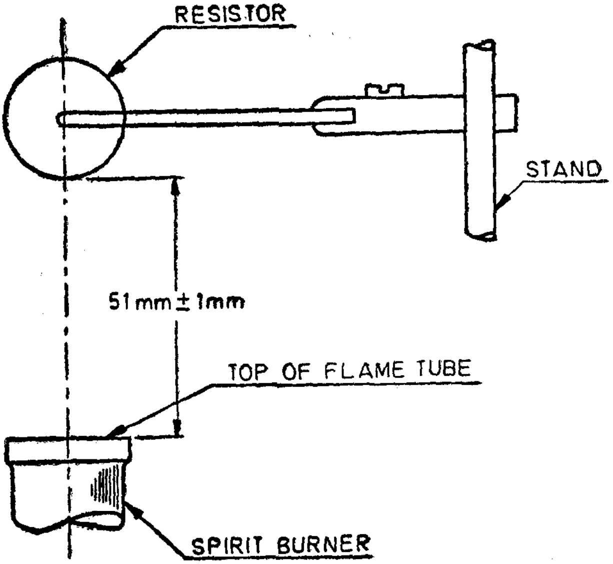

FIG. 5 RELATIVE POSITION OF BURNER AND RESISTOR

A-4. TESTING

A-4.1 After confirming that the flame is satisfactory as specified in **A-2.1**(c), the burner shall be placed underneath the resistors in such a manner that they are enveloped by the flame. The resistor shall be exposed to the flame for either 1 minute or any lesser time necessary to cause ignition.

A-4.2 If ignition has occurred, it shall not continue for more than 15 seconds or any other period specified in the relevant detail specification, after withdrawal of the flame.

A-4.3 No burning particle shall detach from the resistors.